

# Environmental aspects of anthropogenic development of Altai mountain areas

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**Abstract.** The difficulties in finding a balance in the relationship between recreational activities and geosystems are considered. At present there are geoeological problems in mountainous areas of Altai, connected with intensively increasing anthropogenic load on vulnerable landscapes, some elements of geodiversity and territories of remote areas of the Altai Republic. The importance of nature protection and educational function of "Altai" Geopark in protecting the unique elements of geodiversity from human activity is indicated, and in general, the role of "Altai" Geopark and the importance of giving it UNESCO status in further development of ecological and moral tourism in Kosh-Agach region. The issues of overuse of monuments of inanimate nature as objects of excursion show in the context of increasing anthropogenic pressure on them in connection with the increasing annual tourist flow to Kosh-Agachsky district of the Republic of Altai are considered. The role of the development of the geopark "Altai" and giving it the status of UNESCO in the further development of ecological and moral tourism in Kosh-Agachsky area is considered.

## 1 Introduction

In recent years, industrial, agricultural, recreational and transport human development of high-altitude areas has been steadily increasing. The anthropogenic load on unique eco- and geosystems characterized by weak stability is increasing every year.

Intensification of the impact on the environment actualizes the relationship in the system "human-nature". In this regard, the organization of human economic activities must be planned and implemented taking into account ethical, socio-cultural and philosophical issues. There is a certain boundary after which geo- and ecosystems lose the ability to regenerate themselves. Determining this boundary is the main task of geo-ethics. Issues of geo-ethics include sustainable development, protection of geodiversity, prediction and prevention of catastrophic events, rational use of resources [1]. Thus, in any human activity at development of mountain territories geoethical approach should be introduced. Here there is a question of its introduction in the current and planned functioning of the enterprises and behavior of native inhabitants and visitors of mountain regions.

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Intensification of the impact on the environment actualizes the relationship in the system "man-nature". In this regard, the organization of human economic activities must be planned and implemented taking into account ethical, socio-cultural and philosophical issues. There is a certain boundary after which geo- and ecosystems lose the ability to regenerate themselves. Determining this boundary is the main task of geo-ethics. Issues of geo-ethics include sustainable development, protection of geodiversity, prediction and prevention of catastrophic events, rational use of resources [2]. Thus, in any human activity at development of mountain territories geoethical approach should be introduced. Here there is a question of its introduction in the current and planned functioning of the enterprises and behavior of native inhabitants and visitors of mountain regions.

Tourist interest in the Altai Mountains is growing every year, in 2020 the number of visitors to the Altai Mountains reached 2 million 200 thousand people [3]. The intensity of the increase in tourist flow in the Altai Mountains has slightly decreased compared to previous years, when there was a tourist boom in the region, the information support of tourist activity has gradually changed in a positive direction. Of course, this is due to the COVID-19 pandemic that suddenly appeared in the world, closed international borders and restrictions on domestic tourism until July 2020. However, it has also caused unprecedented interest of Russians to Mountain Altai which literally became a dream of millions of people which have paid attention to unique regions of the motherland and rushed to learn it. By that time tour operators had already compiled many guides, booklets, tourist maps, audio guides and atlases. In addition to sports and recreational activities, scientific tourism, including international tourism connected with the study of the geological history of the Altai, its flora and fauna, was actively developing. At the same time there has been a steady growth of interest in the remote regions of the Altai Republic, due to the unique landscape heterogeneity of the territory and its ethnic and cultural uniqueness. One of such regions of the Republic of Altai, to which the intensive tourist flow has rushed relatively recently, has become the high-mountainous Kosh-Agach district.

## **2 Examples of the newest attractions of Kosh-Agach district of the Altai Republic**

The Kyzyl-Chin 1 outcrop, located 2 km upstream of the Akkaya River mouth, is the most representative of the sections of recent deposits in the Altai Mountains, a weathering crust underlain by red-colored sandstones and siltstones of the middle Devonian. Three km upstream of the river in the left side of the valley there is an outcrop Kyzyl-Chin 2, which is one of the most complete stratigraphic sections of deposits of the Altai Mountains, the section clearly traces the occurrence of two formations of Late Neogene, glacial and interglacial Pleistocene formations. Since 2015 the Kyzyl-Chin valley has been actively visited by tourists, who are attracted by the unusually bright colors of outcrops and completely atypical for other parts of Altai landscapes, which are popularly called "Altai Mars".

In the Chagan-Uzun River valley within the end moraine front of the Late Pleistocene mountain-valley glacier, glacial-pond lake sediments were well preserved due to the tortuosity and deep incision of the valley, which contributed to protecting the lake-glacial sediments from wave surfing activities. Lake-glacial sediments of the Chagan-Uzun section are interbedded silty, yellow-gray clay. The sections are represented by exceptionally thin sediments, as the amount of coarse clastic material decreases toward the center of the reservoir, and pebble interlayers can be observed at the base of the ribbon clays. The lake-glacial deposits became a tourist attraction somewhat later than the outcrops in the Kyzyl-Chin valley, excursionists are attracted by the accumulation of white sediments in large numbers, which creates an unusual effect of a desert landscape or, as local guides and private carriers nicknamed this place, "moonscapes".

The Yeshtyköl Plateau is a complex of lakes, frost bumps and swamps, bounded by moraine deposits from the south. The largest lake, Dzhangyskol, has an oval shape and approximate dimensions of 800\*1300 meters. The depth of the lake is 2.-2.5 meters. The water temperature reaches 16-17 degrees Celsius in the summer, so that the lake is actively breeding vegetation. At present, the Kurkurek River feeds the lake through a complex of frost bumps, flowing along their southwestern border. The underlying frozen soils serve as a water retaining horizon and, subject to thawing, as a source of additional moisture, which entails over-watering the area. Lake Dzhangyskol attracts travelers with its mirror-like surface, in which the peaks of the North-Chuya Range are reflected in clear weather. Despite the poor quality of the road with lots of fords, accessible only to prepared vehicles, in recent years there are more and more tours and excursions to the plateau Yoshtykkel, on the shores of the lake built tourist base.

The most large-scale monument of the 2003 Chuya earthquake is a seismic landslide in the valley of the Taldura River. On the right bank of the Taldura river in the zone of earthquake's origin place on September 27, 2003 the biggest trace of it is seismic landslide. Power of the wall of landslide masses detachment makes 150 meters and lies in the spread zone of primary seismic ruptures, one of which, most likely, has become the reason of landslide formation. Along the wall of the fault the landslide moved into the valley at a distance of at least a hundred meters. According to rough estimates, the volume of the landslide mass is  $30 * 106 \text{ m}^3$ . The landslides covered a wide area, confined to sheer rocky ledges. Individual boulders reached the size of a one-story house. The landslide width is about 1 km, the landslide surface is broken by a network of cracks with a width of 1-3 m, and the depth of some cracks exceeds 10 meters. The height of the landslide block is 350 m. The upper part of the landslide is structural, it preserves the original structure of rocks, and the lower part is astructural. Microrelief forms inside the landslide are present: water reservoirs, thermal sinkholes, removal cones, minicanyons, microslides, microslides, structural soil. The landslide impresses travelers with its scale and is an important sightseeing object on the way to the Taldura glacier, which is gaining popularity as a tourist destination.

Lake Kindykykul, located on the foothill plateau between moraine hills and ridges, stretches along the valley of the Naryngol river from west to east. The length of the lake is 2450 m, width - 1750 m, area is 2.77 km<sup>2</sup>. The lake has a complex shape, with several large bays and a cape projecting from the western shore. Opposite the cape is an island, the size of which is 250\*150 meters. The northern half of the lake, relative to the island, is more flowing, while the southern half is less so. The lake has two tributaries on the east side, and a river originates on the northwest side of the lake. The predominant depth of the lake is three to five meters. The water in the lake is transparent and allows you to see the bottom. It is noteworthy that on the island of the lake the vegetation peculiar to the area is preserved, but it disappeared on the shores due to the development of extensive cattle breeding. In recent years, the number of excursions to the lake also increases, conducted by local guides and tours, despite the considerable distance from the Chuy highway and the difficult road to it.

The Taldura Glacier is located on the northern slope of the South Chuya Ridge. The tongue of the glacier is located at an absolute height of 2508 m. With a length of 7.5 km, the area of the Taldura glacier is 28.2 km<sup>2</sup>. At present, the glacier lies in a vast and deep cirque, only slightly intruding into the valley. The Taldura glacier is formed from four glacial streams. At present, the glacier is retreating, leaving typical forms of glacial relief. The number of excursions to the tongue of Taldura glacier increases every year, despite the relative inaccessibility. Excursionists are attracted by the new objects, little developed by mass tourism, and the harsh, virgin nature of the higher.

### 3 The impact of uncontrolled human impact on natural landmarks

Growing year by year people's need for new impressions, recreation and bright emotions, partial closing of external borders and significant complication of foreign travel and more frequent information about Altai in social networks media projects led to a sharp increase of anthropogenic load on the nature of the region as a whole. An important factor of negative impact on ecosystems is tourism, which entails illegal felling and damage to plants, littering of the territory with construction and household garbage even at the stage of construction of new infrastructure facilities. Unorganized tourism leads to the violation of the soil and vegetation cover, land pollution, removal and damage of natural resources, displacement of wildlife. Unique elements of geodiversity are subjected to significant anthropogenic pressure, there is a need for constant monitoring of their condition, based on which measures to regulate the attendance of such sites and their development should be developed. Thus, the Kyzyl-Chin valley, actively visited since 2015, is already significantly affected by anthropogenic impact. At the most visited site, called in the tourist environment "Mars-1", the description of which is given above, massive trails are trampled (Figure 1), it is necessary to equip the area. The vast majority of visitors to the unique outcrop are not aware of its value for science and education, their personal value lies in photos for social networks, they came there for the first and last time and are not interested in the fate of local landscapes.



**Fig. 1.** Trails on Mars-1 and on the way to Mars-2. Kyzyl-Chin Valley 2021. Photo by E.M. Pashkova.

Another newest landmark, called "The Moon", located in the neighboring valley of the Chagan-Uzun River, also suffers greatly from the increased attention of people and vehicular traffic.



**Fig. 2.** Spontaneous road along the lake-glacial deposits of the Chagan-Uzun section.

These sediments are very vulnerable to any impact, their pronounced layering is easily disturbed even by a small physical effort. Today a road runs right along them (Figure 2), no one monitors their condition and the behavior of tourists, and anyone who is not aware of the value of this element of geodiversity can easily irrevocably destroy some part of the deposits.

Negative impact on soil and vegetation cover and natural waters is caused by motor transport, the increase of units of which is constantly observed, the problem of environmental pollution from motor transport is particularly acute in the summer months at the peak of the tourist season, when the number of units of motor vehicles in the Altai Republic dramatically increases. Landscapes of South-Eastern Altai suffer everywhere from uncontrolled traffic of off-road vehicles providing transportation services to visitors of elements of geodiversity, spontaneous appearance of new roads from sight to sight, which has a detrimental effect on vulnerable steppe landscapes.

Another aggravated problem of the Altai highlands, indirectly related to the multiple increase in the number of visitors to the region, is the increase in the amount of solid waste. Littering of the territory is connected with this. On the territory of Republic of Altai there are 251 dumpsites, and none of them meets the requirements of nature protection legislation, thus hundreds of hectares of agricultural lands, settlements and lands within water protection zones are alienated.

## **4 Conclusion**

The main task of tourism development on the territory of Altai today is to inform about the value of the region and some natural monuments for science and education, uniqueness of flora and fauna and its ethnic peculiarity. For this purpose, in our opinion, it is necessary to carry out difficult work on ecological education first of all for all those who are engaged in tourism, so that they can transmit information to all guests of the Altai Republic by chain. The production of media products, printed materials, and regular schools and educational seminars for local residents in all regions of the Altai can help with this. Finding a balance in the relationship between recreational and nonnatural activities must begin with the education and upbringing of those who are actively involved in these activities.

The interaction of tour operators and travel agencies with PAs and Geopark "Altai", which was established in December 2015 [4] and is located on the territory of Kosh-Agach, Onguday and Ust-Koksa areas of the Republic of Altai with an area of 14500 square kilometers can meet the urgent needs in ecological education and education of local residents and guests of the Altai Republic. The geopark is defined as: "a tourist and recreational zone, where geological heritage objects act as part of a unified concept of conservation, education and sustainable development of the territory, where the close connection between geodiversity, biodiversity and culture, as well as between the tangible and intangible heritage of the Altai Republic can be traced." Since this time the Altai Geopark has been included in the UNESCO World Network of Geoparks.

The activities of geoparks functioning all over the world under the aegis of UNESCO are aimed at three main goals: preservation of the territory's geological heritage, popularization of geological and ecological knowledge and achieving continuous improvement in the quality of life of the territory's population, without disturbing the natural way of life of local people.

Obtaining the status of UNESCO Geopark "Altai" will draw international attention to the territory of the Altai Mountains and, most importantly, will solve the problem of geodiversity, biodiversity of the territory and its cultural and historical heritage simultaneously, and, at the same time, promote the development of ecological and moral cognitive tourism.

Today the development and functioning of "Altai" Geopark according to UNESCO principles is included in the strategy of socio-economic development of the Republic of Altai till 2035. At present comprehensive research of geodiversity on the territory of the Geopark

is continuing and work is being done to update the roadmap of support for the Altai Geopark, including a system of monitoring elements of the Altai Geopark geodiversity, recognition of natural sites as natural monuments, development of a system of interaction with the local population on their involvement in Geopark activities, interaction with protected areas in order to consider their experience with tourist organizations, promotion and popularization of Altai Geopark among tourists, plan for the development of infrastructure and its elements and the creation of geopark information centers.

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## References

1. N. K. Nikitina, *Geoetika: teoriya, principy, problemy* (OOO “Geoinformmark”, M., 2012)
2. G. M. Geodiversity, *Valuing and Conserving Abiotic Nature* (John Wiley & Sons Ltd, Chichester, 2004)
3. Informaciya o razvitii turistichestkoj otrasli Respubliki Altaj [Elektronnyj resurs] Respublika Altaj: oficial'nyj sajt (2020). Elektron. dan. URL: <http://www.altai-republic.ru/tourism/development/> (data obrashcheniya: 18.03.2020)
4. O sozdanii geoparka «Altaj» Postanovlenie Respubliki Altaj ot 31.12.2015 461 (2015)